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(Remedial Investigation Subtask 4)

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6. Summary of the Human Health Risk Assessment for Area 3

This section summarizes the approach, methodology, and results of the *human health risk assessment* (HHRA) conducted as part of the *remedial investigation* (RI). The results of the HHRA indicate that action should be taken to protect human health from potential exposure to *contamination* in *groundwater* underlying the San Gabriel Valley Area 3 *Superfund* Site (Area 3). Appendix F provides the complete HHRA, including a detailed narrative and all calculations.

The HHRA evaluates current and potential future cancer risks and noncancer health hazards from potential exposure of residents (adults and children) under *baseline conditions* to *contaminants of potential concern* (COPCs) observed in groundwater in Area 3 (RI Subtask 4).

Baseline conditions assume that no treatment is implemented to address COPCs in groundwater and that no changes in COPC concentrations occur in the future. This baseline assessment evaluates all COPCs, although the report focuses on Key COPCs detected multiple times at production wells within Area 3 at concentrations that exceed *evaluation criteria*.

The results and conclusions of the HHRA help in evaluating whether action is warranted to mitigate potential adverse health effects. Currently, local water purveyors comply with drinking water standards through implementation of various measures to mitigate contamination, including well shutdowns, wellhead treatment, and blending.

6.1 Approach for the HHRA

The HHRA conforms to the regulatory guidelines outlined in Appendix F, which include the following steps.

- Data Evaluation/Hazard Identification (Section 6.1.1)
- Exposure Assessment (Section 6.1.2)
- Toxicity Assessment (Section 6.1.3)
- Risk Characterization (Section 6.1.4)
- *Uncertainty* Analysis (Section 6.1.5)

Table 6-1 presents the *data quality objectives* (DQOs) developed to guide data collection, analysis, and interpretation for the HHRA. Appendix C presents the data quality and usability assessment of the Area 3 data set, which indicates that the data are of sufficient quality and usability for use in the HHRA.

The DQOs define the evaluation to be completed in this subtask and identify potential evaluation results. Methods to avoid incorrect results are also

Each section of this report provides a discussion of the subject, followed by any tables or figures cited in the text. In addition, exhibits and text boxes noted in the margins present key concepts, tables, and figures.

*The glossary explains words presented in **bold, italicized** text.*

Appendix F provides the complete HHRA.

provided. Table 6-1 shows that the risk assessment will only evaluate groundwater data for potentially complete exposure pathways for adult and child residents. Incomplete exposure pathways for groundwater, soil, and *soil vapor* are excluded. Table 6-1 also lists the data needs to complete the subtask and describes how the data will be used. Finally, Table 6-1 includes an evaluation of the assessment conducted to determine the quality and usability of the data set.

Table 6-1 presents the DQOs developed for the HHRA.

Appendix C presents the data quality and usability assessment of the Area 3 data set.

Figure 2-1 shows the location of the monitoring wells and production wells.

Figure 6-1 presents the potential human exposure pathway model.

6.1.1 Data Evaluation/Hazard Identification

This step consists of reviewing, evaluating, and compiling groundwater analytical results for all COPCs detected in Area 3 to complete the baseline assessment. The Key COPCs are a subset of the COPCs. The HHRA considers data through December 2007 contained in the *EPA San Gabriel Basin Database*.

The measurement points include the monitoring wells and production wells located in the five geographic areas identified as southwestern (SW), northwestern (NW), central, northeastern (NE), and southeastern (SE) Area 3. Figure 2-1 shows the location of the wells or measurement points. The measurement points are summarized as follows.

- **SW Area 3** contains 19 facility monitoring wells.
- **NW Area 3** contains two production wells.
- **Central Area 3** contains five monitoring wells and 13 production wells.
- **NE Area 3** contains 16 facility monitoring wells and 12 production wells.
- **SE Area 3** contains 11 production wells.

6.1.2 Exposure Assessment

The exposure assessment builds on the results of the data evaluation/hazard identification process and evaluates exposures that could result under current conditions and under possible future conditions in Area 3 based on potential land uses. The exposure assessment focuses on the following items.

- Populations that might be exposed
- Routes and *exposure pathways* by which individuals could become exposed
- Magnitude, frequency, and duration of potential exposures

Because much of Area 3 consists of residential areas, the HHRA evaluates potential exposures to adult and child resident *receptors*. Although potential exposures to industrial/commercial workers also are possible, this assessment uses residential exposures as the most conservative scenario.

6.1.2.1 Potential Human Exposure Pathway Model

Subsurface investigations at facilities in Area 3 include soil vapor surveys, evaluating the vapor intrusion pathway, soil testing, groundwater monitoring, or a combination of activities. Figure 6-1 presents the *potential human exposure pathway model*, which summarizes information about contamination and transport through the environment to potential human receptors. The potential human pathway exposure model consists of the following components.

- Potential primary contamination sources (commercial and industrial facilities in Area 3)
- Contamination release mechanisms (spills and leaks)
- Potential secondary contamination sources (contaminated soil)
- COPC transport mechanisms (infiltration to groundwater, volatilization to air, and particles/dust emissions to air)
- Contaminated exposure media (contaminated groundwater)
- Potentially complete exposure pathways (for example, consumption of drinking water)
- Exposure routes (ingestion, direct dermal contact, and inhalation of *volatile organic compounds* [VOCs] during domestic water use)
- Potentially exposed receptors (residents and golf course workers)

6.1.2.2 Reasonable Maximum Exposure Estimate

Exhibit 6-1 presents the assumptions used in this HHRA to provide a *reasonable maximum exposure* estimate for adult and child residents. The reasonable maximum exposure determination estimates a conservative exposure, within the range of possible exposures, but well above the average.

EXHIBIT 6-1
Reasonable Maximum Exposure Estimates

Assumption	Adult	Child	Reference
Exposure duration:	24 years	6 years	EPA, 1989
Exposure frequency:	350 days per year	350 days per year	EPA, 1991
Groundwater ingestion rate:	2 liters per day	1 liter per day	EPA, 1989

Exhibit 6-1 presents the reasonable maximum exposures used in the HHRA.

6.1.3 Toxicity Assessment

The toxicity assessment characterizes and quantifies the cancer and noncancer effects of the COPC. The toxic effects of a COPC depend on the exposure route (oral, inhalation, and dermal) and duration of exposure (subchronic, *chronic*, or lifetime).

6.1.4 Risk Characterization

Risk characterization quantifies the potential risks to receptors exposed to COPCs in groundwater in Area 3. This step involves combining the exposure data with toxicity data to provide numerical estimates of potential adverse health effects. The quantification approach differs for potential noncancer and cancer effects, as described below.

The HHRA evaluates the potential for cancer effects by estimating *excess lifetime cancer risk* (ELCR). The ELCR represents the probability that an exposed

individual will develop cancer because of that exposure by age 70. For example, a 2E-06 ELCR means that, for every 1 million people exposed to carcinogens potentially present in groundwater underlying Area 3 throughout their lifetimes, the average incidence of cancer might increase by two cases of cancer. The actual cancer risk is likely less than the risk predicted in the HHRA (United States Environmental Protection Agency [EPA], 1989a).

For noncancer effects, the HHRA estimates the likelihood that a receptor will develop an adverse effect by comparing chronic daily intake with the *reference dose* of the COPC. The ratio of the chronic daily intake divided by the reference dose is termed the *hazard quotient* (HQ). An HQ greater than 1 (that is, exposure that exceeds the reference dose) indicates potential noncancer health effects. The assessment of the potential for noncancer health effects posed by exposure to multiple chemicals uses a *hazard index* (HI) approach according to EPA guidance (EPA, 1989a).

The HHRA estimates human health risks and hazards by comparing the concentrations of COPCs in groundwater in Area 3 against the EPA regional screening level (RSL) for tap water (EPA, 2008c). The RSL values are calculated using data for child resident receptor for noncancer results and data for an integrated adult-child receptor for cancer results.

6.1.5 Uncertainty Analysis for Human Health Risk Assessment

This HHRA qualitatively analyzes uncertainty to identify methods or approaches that could lead to incorrect conclusions based on the results of the HHRA. The risk assessment evaluates the uncertainty associated to increase confidence in the outcomes and decisions made based on the HHRA. The discussion in Section F.3 considers the following sources of uncertainties associated with the data set for Area 3.

- Uncertainty in data collection and analysis
- *Fate* and transport estimation
- Exposure estimation
- Toxicological data
- Risk characterization

6.2 Results of the Human Health Risk Assessment

The evaluation focuses on potential cancer risks and noncancer hazards for adult and child resident receptors from groundwater contamination in Area 3.

Figures 6-2 and 6-3 present the estimated potential cancer risks for adult residents and HIs for child residents, respectively, along with the locations of corresponding measurement points. Results of the risk calculations based on the adult resident receptor yield the most conservative cancer risk estimate; the risk calculations based on the child resident receptor yield the most conservative noncancer health hazards. The presence of several COPCs identified in Table 4-7 also contribute to the estimated risks.

Figures 6-2 and 6-3 present the estimated potential cancer risks for adult residents and hazard indices for child residents, respectively.

The evaluation of potential cancer risks and noncancer health hazards is based on a comparison of the calculated values to the following criteria.

- ELCR values that exceed the risk evaluation criterion of $1E-06$
- HI values that exceed the risk evaluation criterion of 1

Exhibits 6-2 through 6-6 summarize the calculated adult excess cancer and child noncancer results. Appendix F provides Tables F-1 through F-161 that show the complete set of results for the evaluation of data from each measurement point. The following discussions below summarize the calculated adult cancer and child noncancer results.

6.2.1 SW Area 3 – Evaluation of Cancer Risks and Noncancer Hazards

As shown in Exhibit 6-2, estimates of excess cancer risk for the adult resident exceed the risk evaluation criterion of $1E-06$. The highest risk estimate ($1E-03$) is based on data collected at Facility 1, primarily due to the presence of *trichloroethene* (TCE) in groundwater. Two estimated noncancer hazards for the child resident exceed the risk evaluation criterion of 1. The highest HI (2) is based on data collected at Facility 22, due to the presence of *tetrachloroethene* (PCE) in groundwater.

EXHIBIT 6-2

Summary of Estimated Cancer Risks and Noncancer Hazards at Measurement Points in SW Area 3

Measurement Point	Excess Cancer Risk Level	Hazard Index	Primary Contributing COPC(s)
EPAMW11	3E-04	2	PCE, TCE, arsenic ^a
EPAMW18	1E-04	0.3	Arsenic ^a
Facility 1	1E-03	0.8	PCE, TCE, cis-1,2-DCE
Facility 3	2E-04	0.2	PCE, TCE, cis-1,2-DCE
Facility 4	1E-04	0.1	PCE, TCE, carbon tetrachloride
Facility 5	9E-06	0.01	PCE, TCE, cis-1,2-DCE
Facility 6	1E-04	0.2	PCE, TCE, cis-1,2-DCE
Facility 7	5E-06	0.4	PCE, TCE, perchlorate
Facility 8	3E-04	0.4	PCE, TCE
Facility 10	3E-04	0.5	PCE
Facility 22	1E-03	2	PCE
Facility 32	5E-05	0.1	PCE, TCE, naphthalene ^a

^a Contaminant is not considered a **Key COPC**. Key COPCs are used to identify regional groundwater contamination.

The actual cancer risk is likely to be less than that predicted in the HHRA due to the use of conservative exposure assumptions (EPA, 1989).

cis-1,2-DCE – cis-1,2-dichloroethene

COPC – contaminant of potential concern

PCE – tetrachloroethene

SW – southwestern

TCE – trichloroethene

6.2.2 NW Area 3 – Evaluation of Cancer Risks and Noncancer Hazards

As shown in Exhibit 6-3, the estimated cumulative integrated adult-child cancer risks exceed the risk evaluation criterion of $1E-06$. The primary contributors to risk include TCE and PCE in groundwater. Both HIs are less than the risk evaluation criterion of 1. Perchlorate in groundwater is the main contributor to noncancer hazards.

Exhibits 6-2 through 6-6 summarize the calculated adult excess cancer and child noncancer results.

Exhibit 6-2 summarizes the calculated adult excess cancer and child noncancer results for SW Area 3.

Exhibit 6-3 summarizes the calculated adult excess cancer and child noncancer

EXHIBIT 6-3
Summary of Estimated Cancer Risks and Noncancer Hazards at Measurement Points in NW Area 3

Measurement Point	Excess Cancer Risk Level	Hazard Index	Primary Contributing COPC(s)
01900934	7E-06	0.08	TCE, perchlorate
01901679	4E-05	0.5	PCE, perchlorate, nitrate

The actual cancer risk is likely to be less than that predicted in the HHRA due to the use of conservative exposure assumptions (EPA, 1989).

COPC – contaminant of potential concern

NW – northwestern

PCE – tetrachloroethene

TCE – trichloroethene

6.2.3 Central Area 3 – Evaluation of Cancer Risks and Noncancer Hazards

As shown in Exhibit 6-4, estimates of excess cancer risk for the adult resident and integrated adult-child cancer risks exceed the risk evaluation criterion of 1E-06. The primary risk drivers include PCE, TCE, 1,2,3-trichloropropane (1,2,3-TCP), and arsenic in groundwater. The highest risk estimate (1E-04) is based on data collected at EPAMW15. Three estimates of noncancer hazard for the resident child exceed the risk evaluation criterion of 1. The highest HI (3) is based on data collected at EPAMW14, primarily because of the presence of arsenic in groundwater.

Exhibit 6-4 summarizes the calculated adult excess cancer and child noncancer results for Central Area 3.

EXHIBIT 6-4
Summary of Estimated Cancer Risks and Noncancer Hazards at Measurement Points in Central Area 3

Measurement Point	Excess Cancer Risk Level	Hazard Index	Primary Contributing COPC(s)
EPAMW12A	2E-04	1	Arsenic ^a , NDMA ^a , perchlorate
EPAMW13	8E-05	2	Arsenic ^a , dibromochloropropane ^a , perchlorate
EPAMW14	7E-04	3	Arsenic ^a
EPAMW15	1E-04	2	Dibromochloropropane ^a , perchlorate, nitrate
EPAMW17	4E-04	1	Arsenic ^a
01900010	2E-05	0.0005	1,2,3-TCP
01900011	8E-06	0.2	TCE, Perchlorate, Nitrate
01900012	2E-05	0.4	TCE, perchlorate, nitrate
01900014	3E-07	0.1	TCE, perchlorate, nitrate
01900015	8E-07	0.1	TCE, perchlorate, nitrate
01901681	1E-04	0.1	PCE, TCE, perchlorate
01901682	1E-06	0.09	PCE, TCE, nitrate
01903014	3E-05	0.01	PCE, 1,2,3-TCP
01903086	3E-05	0.09	PCE, 1,2,3-TCP, nitrate
01903097	9E-06	0.2	PCE, nitrate

^a Contaminant is not considered a Key COPC. Key COPCs are used to identify regional groundwater contamination.

The actual cancer risk is likely to be less than that predicted in the HHRA due to the use of conservative exposure assumptions (EPA, 1989).

COPC – contaminant of potential concern

NDMA – n-nitrosodimethylamine

PCE – tetrachloroethene

TCE – trichloroethene

1,2,3-TCP – 1,2,3-trichloropropane

6.2.4 NE Area 3 – Evaluation of Cancer Risks and Noncancer Hazards

As shown in Exhibit 6-5, estimates of excess cancer risk for the adult resident and integrated adult-child cancer risks exceed the risk evaluation criterion of 1E-06. The primary contributors to risk include arsenic, PCE, perchlorate, and nitrate in groundwater. Two estimates of noncancer hazard for the resident child exceed the risk evaluation criterion of 1. The highest HI (38) is based on data collected at Facility 19.

EXHIBIT 6-5

Summary of Estimated Cancer Risks and Noncancer Hazards at Measurement Points in NE Area 3

Measurement Point	Excess Cancer Risk Level	Hazard Index	Primary Contributing COPC(s)
EPAMW16	3E-05	1	Arsenic ^a
Facility 19	5E-03	38	PCE, 1,2,4-trimethylbenzene ^a
Facility 21	8E-06	0.02	PCE, benzene ^a
01900017	N/A	0.2	Nitrate, perchlorate
01900026	N/A	0.04	Nitrate
01900547	1E-05	0.5	Arsenic ^a , perchlorate, nitrate
01900935	5E-04	0.4	PCE, nitrate, perchlorate
01901671	5E-06	0.2	Atrazine ^a , nitrate, perchlorate
01902785	2E-05	0.01	PCE
01902786	1E-04	0.01	PCE
01902972	N/A	0.07	Nitrate
01902979	1E-05	0.2	Arsenic ^a , PCE, perchlorate
01903059	N/A	0.1	Perchlorate
08000157	N/A	0.02	Nitrate

^a Contaminant is not considered a Key COPC. Key COPCs are used to identify regional groundwater contamination.

The actual cancer risk is likely to be less than that predicted in the HHRA due to the use of conservative exposure assumptions (EPA, 1989).

COPC – contaminant of potential concern

N/A – Excess cancer risk not calculated as COPCs only contribute to noncancer health risks

NE – northeastern

PCE – tetrachloroethene

6.2.5 SE Area 3 – Evaluation of Cancer Risks and Noncancer Hazards

As shown in Exhibit 6-6, six of the seven estimated values for cumulative cancer risk exceed the risk evaluation criterion of 1E-06. The primary risk drivers include PCE and TCE in groundwater. The highest risk estimate (2E-05) is based on data collected at Production Well 01900927. None of the estimated noncancer hazards exceed the risk evaluation criterion of 1.

Exhibit 6-5 summarizes the calculated adult excess cancer and child noncancer results for NE Area 3.

Exhibit 6-6 summarizes the calculated adult excess cancer and child noncancer results for SE Area 3.

EXHIBIT 6-6

Summary of Estimated Cancer Risks and Noncancer Hazards at Measurement Points in SE Area 3

Measurement Point	Excess Cancer Risk Level	Hazard Index	Primary Contributing COPC(s)
01900514	N/A	0.009	Nitrate
01900515	8E-06	0.004	PCE
01900926	9E-06	0.1	PCE, nitrate, perchlorate
01900927	2E-05	0.2	PCE, nitrate, perchlorate
01901669	9E-06	0.005	PCE, TCE
08000067	1E-05	0.07	PCE, nitrate
08000123	1E-07	0.02	TCE, nitrate
08000133	3E-06	0.01	PCE, 1,2,3-TCP, nitrate
08000146	N/A	0.004	Nitrate

The actual cancer risk is likely to be less than that predicted in the HHRA due to the use of conservative exposure assumptions (EPA, 1989).

COPC –contaminant of potential concern

N/A – Excess cancer risk not calculated as COPCs only contribute to noncancer health risks.

PCE – tetrachloroethene

SE – southeastern

TCE – trichloroethene

6.3 Summary of the Human Health Risk Assessment for Area 3

The HHRA evaluates the need for a comprehensive *remedial action* to address regional groundwater contamination in Area 3, rather than the need for discrete actions to address contamination observed at individual facilities. This HHRA confirms that COPCs adversely affect the groundwater resources in each of the five regions of Area 3.

The risk estimates based on data collected from 42 of 52 measurement points exceed the 1E-06 risk evaluation criterion, based mainly on the presence of PCE and TCE contamination. The noncancer HIs based on data collected from nine of the 52 measurement points equal or exceed the noncancer risk evaluation criterion of 1. The highest cancer risk estimate of 5E-03 and highest HI estimate of 38 are based on data collected from Facility 19 in NE Area 3.

Results of the HHRA indicate that groundwater is significantly impacted by COPCs at multiple locations in Area 3. Due to this contamination, untreated groundwater in many parts of Area 3 is unsuitable as a source of tap water for domestic use. The HHRA recommends that action be taken to protect human health in Area 3.

Section 8 discusses the next steps for Area 3, including the *feasibility study* to evaluate remedial alternatives to address the regional groundwater contamination in Area 3. The *contaminants of concern* include the contaminants

that were identified in the HHRA as potential risk contributors and will be addressed during the feasibility study. The potential risk contributors include the Key COPCs and the following COPCs: arsenic, naphthalene, NDMA, dibromochloropropane, 1,2,4-trimethylbenzene, benzene, and atrazine. Groundwater monitoring will continue during the feasibility study and the additional data collected will be evaluated to determine the impact of these contaminants in groundwater underlying Area 3.

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Glossary

Glossary

1.0E-06 Risk: A screening criterion and estimate of risk that indicates for every 1 million people exposed to carcinogens throughout their lifetimes, the average incidence of cancer might increase by one case of cancer.

baseline condition: A risk assessment term describing current conditions without consideration of any changes to chemical concentrations that would occur either from remedial action or natural attenuation, or changes in land use that might modify the exposure assumptions.

chronic: Long-term exposure or adverse effect. Sub-lethal effects (e.g., growth or reproduction) that may be measured over a long exposure period.

contaminant: A substance not naturally present in the environment or present in unnatural concentrations that can, in sufficient concentration, adversely alter an environment.

contaminants of concern: The contaminants which have been shown through a risk assessment to be those that are likely to be causing risk to receptors at a site.

contaminants of potential concern: Contaminants that potentially pose a risk to human health or the environment.

contamination: The presence of hazardous substances in the environment.

data quality objectives: Performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

EPA San Gabriel Basin Database: A collection of electronic data maintained by EPA from testing performed at groundwater wells throughout the San Gabriel Valley. The database includes construction information and historical laboratory data from monitoring wells and production wells.

evaluation criterion: A standard or reference point on which a decision will be assessed.

exposure pathway: Route by which a contaminant travels from a source (e.g., leaky tank or contaminated soil) to receptors. A pathway can involve multiple media (e.g., soil runoff to surface waters and sediment, or volatilization to the atmosphere).

excess lifetime cancer risk: The incremental increase in the probability of developing cancer in one's lifetime in addition to the background probability of developing cancer (that is, if no exposure to chemicals occur).

- fate:** The processes by which the contaminant moves through and is transformed in the environment.
- feasibility study:** The mechanism for the development, screening, and detailed evaluation of alternative remedial actions.
- groundwater:** Water occurring underground, in the zone of saturation in an aquifer.
- hazard index:** A summation of the hazard quotients for all chemicals to which an individual is exposed. A hazard index value of 1 or less indicates that no adverse human health effects (noncancer) are expected to occur.
- hazard quotient:** The ratio of the estimated intake to the reference dose. The value is used to evaluate the potential for noncancer health effects, such as organ damage, from chemical exposures.
- human health risk assessment:** Qualitative and quantitative evaluation of the risk posed to human health by the actual or potential presence of specific contaminants.
- Key contaminants of potential concern:** The contaminants detected multiple times in groundwater at production wells within Area 3 at concentrations that exceed evaluation criteria.
- maximum contaminant levels:** The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.
- notification level:** Health-based advisory levels (formerly referred to as Action Levels) established by the California Department of Public Health for certain chemicals for which no established drinking water standards exist.
- potential human exposure pathway model:** A schematic diagram that identifies the primary source of contamination in the environment, shows how chemicals might move in the environment, and identifies the different receptors who might come into contact with contaminated media.
- reasonable maximum exposure:** The highest exposure to contamination that is reasonably expected to occur at a site.
- receptor:** A plant or animal species used to estimate the potential exposure to contamination and likelihood of adverse effects to similar organisms in the environment.
- reference dose:** A numerical estimate of a daily oral exposure to a contaminant that is not likely to cause harmful effects to the human population, including sensitive subgroups such as children, during a lifetime.
- remedial investigation:** Actions undertaken to characterize the full nature and extent of contamination, including characterization of hazardous

substances, identification of contaminant sources, and assessment of human health and ecological risk.

soil vapor: Elements and compounds in a gaseous state in the small spaces between particles of soil. Such gases can be moved or driven out under pressure.

Superfund: The program operated under the legislative authority of CERCLA and SARA that funds and carries out EPA solid waste emergency and long-term response actions, including conducting or supervising cleanup actions.

tetrachloroethene: A volatile organic compound primarily used for dry cleaning clothing and in manufacturing processes as a solvent and metal degreaser.

trichloroethene: A volatile organic compound that is a colorless or blue organic liquid with a chloroform-like odor. TCE is primarily used in manufacturing processes as a solvent, metal degreaser, and textile degreaser.

uncertainty: Variability in natural processes, imperfect or incomplete knowledge, or errors in modeling and estimating the potential for risk to human and ecological receptors.

volatile organic compound: An organic (carbon-containing) compound that evaporates readily at room temperature.

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Tables

Figures
